Impacts of changes in phenology on land-atmosphere interactions in temperate and boreal regions

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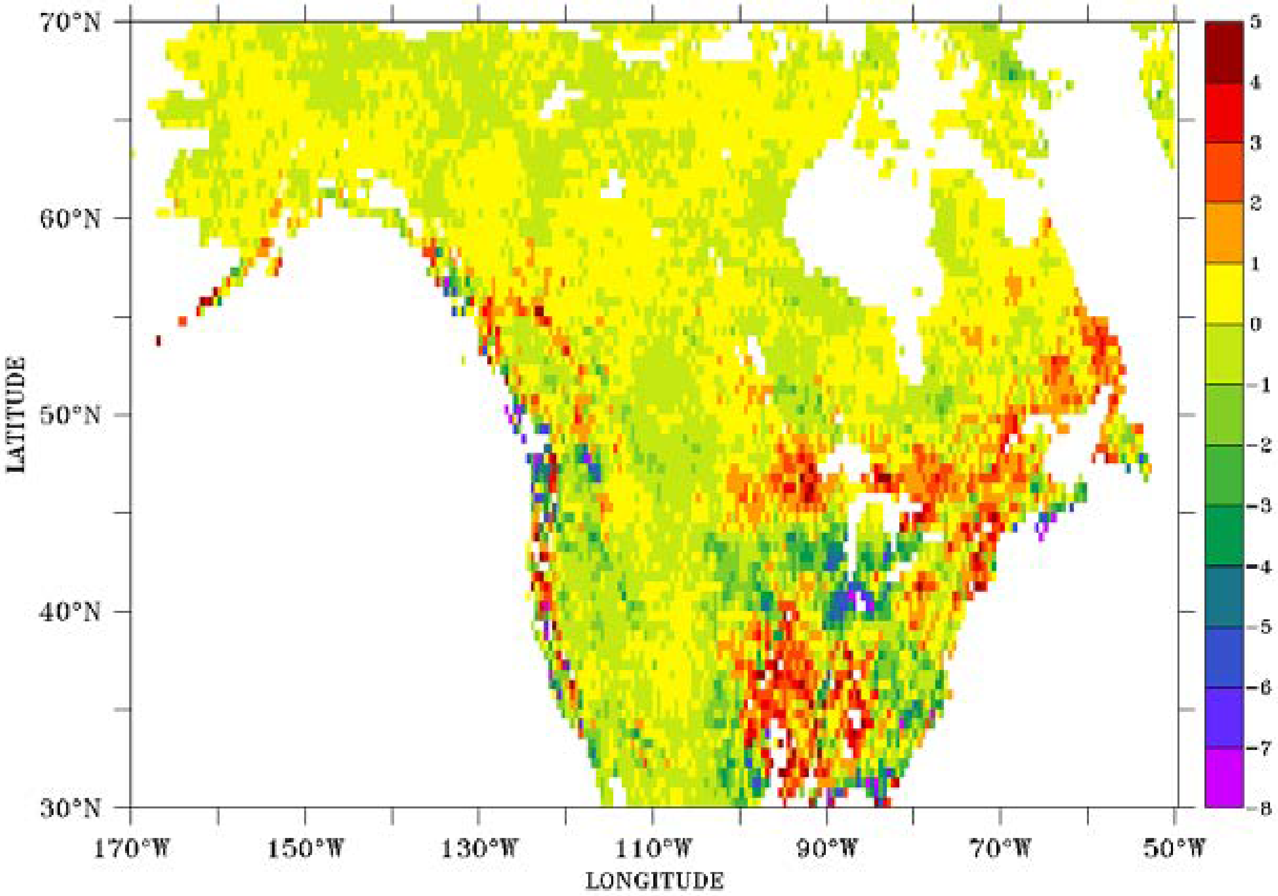
Recent remote sensing data and ground observations have shown earlier leaf out in spring in the northern hemisphere, which is believed to result from climate warming. The advance of leaf out would be expected to have impacts on the dynamics of the wider ecosystem processes such as primary production and evapotranspiration. Moreover, controlled experiments show that temperate and boreal trees require chilling in winter for rapid leaf out in spring. If the amount of chilling falls below a species specific threshold then an exponentially increasing amount of warming is required to initiate leaf out –potentially actually delaying it in a warmer climate. Implications of these chilling requirements for a delayed greening of vegetation at the biome level are not clear. Impacts of changes in the phenology in the past thirty years are explored by incorporating Leaf Area Index (LAI) data derived from satellite remote sensing observed Normalized Difference Vegetation Index (NDVI) into the Joint UK Land Environment Simulator (JULES), a numerical biosphere-atmosphere exchange simulation system. A 30 year model simulation using daily varying climate and monthly varying LAI is compared to a simulation with the varying climate but a fixed seasonal cycle. So, while the LAI varies between months in the second simulation, the LAI is the same for all 30 Januaries, for all 30 Februaries and so on. The first simulation shows the effects of varying climate and phenology over the last 30 years on the northern hemisphere, the second reflects only the climate variability. The analysis of the simulations shows that there are significant changes due to the changes in the phenology in the biosphere-atmosphere fluxes in some areas of the northern hemisphere. In particular the net primary productivity increases significantly for example in the South Eastern United States. Further changes in the biosphere-atmosphere fluxes are explored. The results highlight the necessity of including appropriate phenology models in climate models for improved predictions of land-atmosphere interactions.

Keywords: Plant Phenology, JULES, Biosphere-atmosphere exchange, Net Primary productivity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60°N
50°N
40°N
30°N
LATITUDE
170°W
150°W
130°W
110°W
90°W
70°W
50°W
LONGITUDE
5
4
3
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-8

